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February 27, 2004

Via HAND DELIVERY

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

RECEIVED

FEB 27 2004

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

**Re: In the Matter of Application of EchoStar for Authority to Construct, Launch and Operate a Direct Broadcast Satellite in the 12.2-12.7 GHz and 17.3-17.8 GHz Frequency Bands at the 86.5° W.L. Orbital Location
File No. SAT-LOA-20030609-00113, Call Sign S2454**

Dear Ms. Dortch:

On behalf of EchoStar Satellite L.L.C. ("EchoStar"), formerly known as EchoStar Satellite Corporation, enclosed please find an original and nine copies of an Amendment on FCC Form 312 and Supplemental Technical Annex for association with the above-referenced application. This Amendment is being provided in response to the February 12, 2004 letter from Thomas S. Tycz, Chief, Satellite Division, International Bureau, to David K. Moskowitz, Senior Vice President and General Counsel of EchoStar, requesting additional technical information in accordance with Section 25.114(c) of the Commission's Rules. You should also be aware that the application, as amended, is in conformance with Section 25.202(g) of the Rules, and no waiver of the rules is required for the proposed TT&C operations.

Marlene H. Dortch
February 27, 2004
Page 2

Please do not hesitate to contact the undersigned should you have any questions with respect to this filing.

Respectfully submitted,



Philip L. Malet
Pantelis Michalopoulos

Attorneys for EchoStar Satellite L.L.C.

Enclosures

cc: Thomas S. Tycz
Arthur Lechtman
Chip Fleming

**FCC 312
Main Form****FEDERAL COMMUNICATIONS COMMISSION****APPLICATION FOR SATELLITE SPACE AND EARTH STATION AUTHORIZATIONS**Approved by OMB
3060-0678
Est. Avg. Burden Hours
Per Response: 11 Hrs.

FCC Use Only

File Number:

Call Sign:

Fee Number:

APPLICANT INFORMATION

1. Legal Name of Applicant EchoStar Satellite L.L.C.		2. Voice Telephone Number (303) 723-1000	
3. Other Name Used for Doing Business (if any)		4. Fax Telephone Number (303) 723-1608	
5. Mailing Street Address or P.O. Box 9601 South Meridian Blvd.		6. City Englewood	8. Zip Code 80112
ATTENTION: David K. Moskowitz		7. State / Country (if not U.S.A.) CO	
9. Name of Contact Representative (if other than applicant) Pantelis Michalopoulos			
11. Firm or Company Name Steptoe & Johnson LLP			
13. Mailing Street Address or P.O. Box 1330 Connecticut Avenue, N.W.			
ATTENTION:			
10. Voice Telephone Number (202) 429-6494		12. Fax Telephone Number (202) 429-3902	
14. City Washington		16. Zip Code 20036-1795	
15. State / Country (if not U.S.A.) DC			

CLASSIFICATION OF FILING

17. Place an "X" in the box next to the classification that applies to this filing for both questions a. and b. Mark only one box for 17a and only one box for 17b.	
<input type="checkbox"/> a1. Earth Station	<input type="checkbox"/> b1. Application for License of New Station
<input checked="" type="checkbox"/> a2. Space Station	<input type="checkbox"/> b2. Application for Registration of New Domestic Receive-Only Station
	<input checked="" type="checkbox"/> b3. Amendment to a Pending Application
	<input type="checkbox"/> b4. Modification of License or Registration
	<input type="checkbox"/> b5. Assignment of License or Registration
18. If this filing is in reference to an existing station, enter: Call sign of station: S2454	
19. If this filing is an amendment to a pending application enter: (a) Date pending application was filed: June 9, 2003 (b) File number of pending application: SAT-LOA-20030609-00113	

TYPE OF SERVICE

20. NATURE OF SERVICE: This filing is for an authorization to provide or use the following type(s) of service(s): Place an "X" in the box(es) next to all that apply.

<input type="checkbox"/> a. Fixed Satellite	<input type="checkbox"/> c. Radiodetermination Satellite	<input type="checkbox"/> e. Direct to Home Fixed Satellite
<input type="checkbox"/> b. Mobile Satellite	<input type="checkbox"/> d. Earth Exploration Satellite	<input type="checkbox"/> f. Digital Audio Radio Service
		<input checked="" type="checkbox"/> g. Other (please specify) Broadcasting Satellite Service

21. STATUS: Place an "X" in the box next to the applicable status. Mark only one box.

<input type="checkbox"/> a. Common Carrier	<input checked="" type="checkbox"/> b. Non-Common Carrier
--	---

22. If earth station applicant, place an "X" in the box(es) next to all that apply.

<input type="checkbox"/> a. Using U.S. licensed satellites	<input type="checkbox"/> b. Using Non-U.S. licensed satellites
--	--

N/A

23. If applicant is providing INTERNATIONAL COMMON CARRIER service, see instructions regarding Sec. 214 filings. Mark only one box. Are these facilities:

<input type="checkbox"/> a. Connected to the Public Switched Network	<input type="checkbox"/> b. Not connected to the Public Switched Network
--	--

N/A

24. FREQUENCY BAND(S): Place an "X" in the box(es) next to all applicable frequency band(s).

<input type="checkbox"/> a. C-Band (4/6 GHz)	<input type="checkbox"/> b. Ku-Band (12/14 GHz)	<input checked="" type="checkbox"/> c. Other (Please specify) 12.2-12.7 GHz; 17.3-17.8 GHz
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TYPE OF STATION

25. CLASS OF STATION: Place an "X" in the box next to the class of station that applies. Mark only one box.

<input type="checkbox"/> a. Fixed Earth Station	<input type="checkbox"/> b. Temporary-Fixed Earth Station	<input type="checkbox"/> c. 12/14 GHz VSAT Network	<input checked="" type="checkbox"/> d. Mobile Earth Station	<input type="checkbox"/> e. Space Station	<input type="checkbox"/> f. Other (Specify)
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If space station applicant, go to Question 27.

26. TYPE OF EARTH STATION FACILITY Mark only one box.

<input type="checkbox"/> a. Transmit/Receive	<input type="checkbox"/> b. Transmit-Only	<input type="checkbox"/> c. Receive-Only	N/A
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PURPOSE OF MODIFICATION OR AMENDMENT

27. The purpose of this proposed modification or amendment is to: Place an "X" in the box(es) next to all that apply.

<input type="checkbox"/> a -- authorization to add new emission designator and related service	<input type="checkbox"/> b -- authorization to change emission designator and related service	<input type="checkbox"/> c -- authorization to increase EIRP and EIRP density	<input type="checkbox"/> d -- authorization to replace antenna	<input type="checkbox"/> e -- authorization to add antenna	<input type="checkbox"/> f -- authorization to relocate fixed station	<input type="checkbox"/> g -- authorization to change assigned frequency(ies)	<input type="checkbox"/> h -- authorization to add Points of Communication (satellites & countries)	<input type="checkbox"/> i -- authorization to change Points of Communication (satellites & countries)	<input type="checkbox"/> j -- authorization for facilities for which environmental assessment and radiation hazard reporting is required	<input checked="" type="checkbox"/> k -- Other (Please Specify)
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Supplement original application with additional technical information

ENVIRONMENTAL POLICY

28. Would a Commission grant of any proposal in this application or amendment have a significant environmental impact as defined by 47 CFR 1.1307? If YES, submit the statement as required by Sections 1.1308 and 1.1311 of the Commission's rules, 47 C.F.R. §§ 1.1308 and 1.1311, as an exhibit to this application.

A Radiation Hazard Study must accompany all applications as an exhibit for new transmitting facilities, major modifications, or major amendments. Refer to OET Bulletin 65.

<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
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ALIEN OWNERSHIP

29. Is the applicant a foreign government or the representative of any foreign government?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
30. Is the applicant an alien or the representative of an alien?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
31. Is the applicant a corporation organized under the laws of any foreign government?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
32. Is the applicant a corporation of which more than one-fifth of the capital stock is owned of record or voted by aliens or their representatives or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
33. Is the applicant a corporation directly or indirectly controlled by any other corporation of which more than one-fourth of the capital stock is owned of record or voted by aliens, their representatives, or by a foreign government or representative thereof or by any corporation organized under the laws of a foreign country?	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
34. If any answer to questions 29, 30, 31, 32 and/or 33 is Yes, attach as an exhibit, the identification of the aliens or foreign entities, their nationality, their relationship to the applicant, and the percentage of stock they own or vote.		

BASIC QUALIFICATIONS

35. Does the applicant request any waivers or exemptions from any of the Commission's Rules? If Yes, attach as an exhibit, copies of the requests for waivers or exceptions with supporting documents.	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
36. Has the applicant or any party to this application had any FCC station authorization or license revoked or had any application for an initial, modification or renewal of FCC station authorization, license, or construction permit denied by the Commission? If Yes, attach as an exhibit, an explanation of the circumstances.	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
37. Has the applicant, or any party to this application, or any party directly or indirectly controlling the applicant ever been convicted of a felony by any state or federal court? If Yes, attach as an exhibit, an explanation of the circumstances.	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
38. Has any court finally adjudged the applicant, or any person directly or indirectly controlling the applicant, guilty of unlawfully monopolizing or attempting unlawfully to monopolize radio communication, directly or indirectly, through control of manufacture or sale of radio apparatus, exclusive traffic arrangement or any other means or unfair methods of competition? If Yes, attach as an exhibit, an explanation of the circumstances.	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
39. Is the applicant, or any person directly or indirectly controlling the applicant, currently a party in any pending matter referred to in the preceding two items? If Yes, attach as an exhibit, an explanation of the circumstances.	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
40. If the applicant is a corporation and is applying for a space station license, attach as an exhibit the names, addresses, and citizenship of those stockholders owning of record and/or voting 10 percent or more of the Filer's voting stock and the percentages so held. In the case of fiduciary control, indicate the beneficiary(ies) or class of beneficiaries. Also list the names and addresses of the officers and directors of the Filer.		
41. By checking Yes, the undersigned certifies, that neither the applicant nor any other party to the application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Act of 1988, 21 U.S.C. Section 862, because of a conviction for possession or distribution of a controlled substance. See 47 CFR 1.2002(b) for the meaning of "party to the application" for these purposes.	<input checked="" type="checkbox"/> YES	<input type="checkbox"/> NO
42a. Does the applicant intend to use a non-U.S. licensed satellite to provide service in the United States? If yes, answer 42b and attach an exhibit providing the information specified in 47 C.F.R. § 25.137, as appropriate. If no, proceed to question 43.	<input type="checkbox"/> YES	<input checked="" type="checkbox"/> NO
42b. What administration has licensed or is in the process of licensing the space station? If no license will be issued, what administration has coordinated or is in the process of coordinating the space station?	N/A	

See attached Supplemental Technical Annex in response to Letter from Thomas S. Tycz to David K. Moskowitz (Feb. 12, 2004).

[illegible]

CERTIFICATION

The Applicant waives any claim to the use of any particular frequency or of the electromagnetic spectrum as against the regulatory power of the United States because of the previous use of the same, whether by license or otherwise, and requests an authorization in accordance with this application. The applicant certifies that grant of this application would not cause the applicant to be in violation of the spectrum aggregation limit in 47 CFR Part 20. All statements made in exhibits are a material part hereof and are incorporated herein as if set out in full in this application. The undersigned, individually and for the applicant, hereby certifies that all statements made in this application and in all attached exhibits are true, complete and correct to the best of his or her knowledge and belief, and are made in good faith.

44. Applicant is a (an): (Place an "X" in the box next to applicable response.)

☐ a. Individual ☐ b. Unincorporated Association ☐ c. Partnership ☒ d. Corporation ☐ e. Governmental Entity ☐ f. Other (Please specify)

45. Typed Name of Person Signing

(Please specify)

46. Title of Person Signing

David K. Moskowitz

Senior Vice President and General Counsel

47. Signature

48. Date

Feb. 27, 2004

WILLFUL FALSE STATEMENTS MADE ON THIS FORM ARE PUNISHABLE BY FINE AND/OR IMPRISONMENT (U.S. Code, Title 18, Section 1001), AND/OR REVOCATION OF ANY STATION AUTHORIZATION (U.S. Code, Title 47, Section 312(a)(1)), AND/OR FORFEITURE (U.S. Code, Title 47, Section 503).

Response to Question 36

In a Memorandum Opinion and Order released May 16, 2002, the Satellite Division of the International Bureau cancelled two conditional construction permits held by EchoStar affiliates for 22 channels at the 175° W.L. orbital location. *See In the Matter of EchoStar Satellite Corporation, Directsat Corporation, Direct Broadcasting Satellite Corporation, Consolidated Request for Additional Time to Commence Operation*, Memorandum Opinion and Order, DA 02-1164 (rel. May 16, 2002).

By Order released July 1, 2002, the International Bureau cancelled EchoStar's license for a Ka-band satellite system and dismissed a related modification application filed by EchoStar. *See In the Matter of EchoStar Satellite Corporation; Application for Authority to Construct, Launch, and Operate a Ka-band Satellite System in the Fixed-Satellite Service*, Memorandum Opinion and Order, DA 02-1534 (rel. July 1, 2002). On November 8, 2002, the International Bureau reinstated EchoStar's license for a Ka-band system as well as the related modification application. *See In the Matter of EchoStar Satellite Corporation; Application for Authority to Construct, Launch, and Operate a Ka-band Satellite System in the Fixed-Satellite Service*, Memorandum Opinion and Order, DA 02-3085 (rel. Nov. 8, 2002).

Response to Question 40

OWNERSHIP AND CORPORATE
OFFICERS AND DIRECTORS

OWNERSHIP

EchoStar Satellite L.L.C. is an indirect, wholly-owned subsidiary of EchoStar Communications Corporation (a Nevada corporation). The stockholders owning of record and/or voting 10 percent or more of the voting stock of EchoStar Communications Corporation include:

<u>Ownership Interest</u>	<u>Citizenship</u>	<u>Approx. Equity Interest</u> ¹
Charles W. Ergen ² Chairman and CEO EchoStar Communications Corporation 9601 South Meridian Blvd. Englewood, CO 80112	USA	49.8%
Fidelity Management and Research Corporation 82 Devonshire Street Boston, MA 02109	USA (Massachusetts corporation)	15.1%

¹ As of December 11, 2003. Mr. Ergen and Fidelity Management and Research Corporation have an approximately 91% and 1% voting interest, respectively, in EchoStar Communications Corporation.

² Includes both Class A common and Class B common stock ownership. Class B common stock is owned through a family trust.

CORPORATE OFFICERS AND DIRECTORS³

EchoStar Communications Corporation

Executive Officers:

Charles W. Ergen - Chief Executive Officer
Soraya Cartwright - Executive Vice President - DISH Network
James DeFranco - Executive Vice President
Michael T. Dugan - President and Chief Operating Officer
David K. Moskowitz - Senior Vice President, General Counsel and Secretary
Steven B. Schaver - President - EchoStar International Corporation
Michael R. McDonnell - Senior Vice President and Chief Financial Officer
Mark W. Jackson - Senior Vice President - EchoStar Technologies Corporation
Michael Schwimmer - Senior Vice President of Programming
Michael Kelly - Senior Vice President - DISH Network Service Corporation
O. Nolan Daines - Senior Vice President

Board of Directors:

Charles W. Ergen - Chairman
Steven R. Goodbarn
James DeFranco
David K. Moskowitz
Peter A. Dea
Cantey M. Ergen
Raymond L. Friedlob
C. Michael Schroeder

³ The address for all officers and directors of EchoStar Communications Corporation and EchoStar Satellite L.L.C. is 9601 South Meridian Blvd., Englewood, CO 80112.

EchoStar Satellite L.L.C.

Executive Officers:

Charles W. Ergen: President and Chief Executive Officer

James DeFranco: Executive Vice President

David K. Moskowitz: Senior Vice President, General Counsel and Secretary

Board of Directors:

Charles W. Ergen - Chairman

James DeFranco

David K. Moskowitz

SUPPLEMENTAL TECHNICAL ANNEX

ECHOSTAR-86.5 W DBS SATELLITE

1 Introduction

This Supplemental Technical Annex provides the additional information requested in the letter dated February 12, 2004, from Thomas S. Tycz to David Moskowitz (the "FCC Letter") for the proposed EchoStar-86.5W DBS satellite.

2 Responses to Numbered Paragraph 1 in the FCC Letter (ref. §25.114(c)(5))

2.1 Emission designators and allocated bandwidths of the telemetry emissions

The emission designators and associated allocated bandwidths for both the telemetry and telecommand emissions are as follows:

Telecommand: 1M50G2D (1.5 MHz)

Telemetry: 1M50G2D (1.5 MHz)

2.2 Final amplifier output power of the telemetry transmitters

The telemetry EIRP budget is given in Table 1 below. From this budget the final amplifier output power would be -10.0 dBW (0.1 Watt) for normal operations through the communications antenna, and 8 dBW (6.3 Watts) for transfer orbit or emergency mode operations through either the wide-angle horn or omni antennas. These power levels are reduced by 10.0 dB for the communications antenna, 13.0 dB for the horn antenna and 6.0 dB for the omni antennas due to losses between the final output amplifier and the transmit antenna flange, as shown in Table 1.

Table 1 - Telemetry EIRP Budget

Parameter	Communications Antenna	Wide Angle Antennas		Unit
		Wide Angle Horn	Omni	
Transmit Power	-10.0	8.0	8.0	dBW
Line Loss	-10.0	-13.0	-6.0	dBW
Antenna Gain (EOC)	28.0	7.0	-0.5	dBi
EIRP	8.0	2.0	1.5	dBW

2.3 Receiving system noise temperature for the telecommand receivers

The telecommand G/T budget is given in Table 2 below. The G/T performance varies as a function of the antenna gain and the corresponding losses between the receive antenna and the telecommand receiver. The resulting G/T performance (at edge-of-coverage) would vary from -18.0 dB/K in the case of the communications antenna to -33.5 dB/K for the omni antenna.

Table 2 - Telecommand G/T Budget

Parameter	Communications Antenna	Wide Angle Antennas		Unit
		Wide Angle Horn	Omni	
Antenna Gain (EOC)	28.0	7.0	-0.5	dBi
Losses	23.0	12.0	10.0	dB
Rx Noise Temperature (incl. allowance for antenna noise)	23.0	23.8	24.0	dBK
G/T	-18.0	-28.8	-33.5	dB/K

2.4 Relationship between satellite receive antenna gain pattern and gain-to-temperature ratio and saturation flux density for each antenna beam

Figure 3-1 in the Technical Annex of the EchoStar Application for the EchoStar-86.5W satellite provides G/T gain contours for the satellite receive beam. The peak G/T value is +10.4 dB/K. This corresponds to a receive system noise temperature of 912K and a peak gain of 40.0 dBi. This antenna gain has an effective aperture of -6.3 dB-m^2 at the frequency of 17.55 GHz.

The corresponding Saturation Flux Density ("SFD") for this beam varies from -75 dBW/m^2 (low gain) to -95 dBW/m^2 (high gain) at receive beam peak, depending on the transponder gain. The relative SFD contours will match the relative G/T contours of Figure 3-1 of the EchoStar Application for the EchoStar-86.5W satellite, referenced to these beam peak SFD values.

2.5 Gain of each transponder channel

The transponder gain is controlled by an Automatic Level Control ("ALC") system which automatically adjusts the transponder gain to give a constant satellite transmit power level for each transponder. The transponder gain for the two extreme ends of the ALC range (corresponding to the range of SFD values given in section 2.4 above), under TWTA saturation conditions in low power mode, will range from 100.3 dB (low gain) to 120.3 dB (high gain). In high power mode the gain values will be 2.8 dB higher.

2.6 Predicted receiver and transmitter channel filter response characteristics

The typical receiver and transmitter frequency responses of each RF channel, as measured between the receive antenna input and transmit antenna, will fall within the limits shown in Table 3 below.

In addition, the frequency tolerances of §25.202(e) and the out-of-band emission limits of §25.202(f) (1), (2) and (3) will be met.

Table 3 - Typical Receiver and Transmitter Filter Responses

Offset from Channel Center Frequency (MHz)	Receiver Filter Response (dB)	Transmitter Filter Response (dB)
± 5	> -0.5	> -0.4
± 7	> -0.7	> -0.5
±9	> -1.0	> -0.8
± 11	> -1.5	> -1.7
±12	> -2.0	> -3.6
±17.5	< -18	< -8
±20.2	< -38	< -18
±27.2	< -50	< -35

3 Responses to Numbered Paragraph 2 in the FCC Letter (ref. §25.114(c)(8))

3.1 Performance objectives for each type of proposed service

The overall performance objective is to provide high availability broadcast satellite services to subscribers using a receive antenna as small as 45 cm in diameter. The availability is determined by the rain fade statistics that vary considerably over the service area, even within CONUS. To partly compensate for this variation, the satellite EIRP is tailored to generally match the rain fade statistics over the service area, resulting in higher EIRP levels being delivered to the south and east of CONUS than to other parts of the U.S. With this design approach, availabilities generally in excess of 99.7% are achieved when operating in the low power mode (120W TWTA per transponder). For geographic locations where the rainfall rate is particularly high then the availability using a 45 cm receive antenna may fall below 99.7%, or alternatively a slightly larger receive antenna may be used to maintain the higher availability.

3.2 Link noise budgets and overall link performance analysis

Table 4 below provides some representative link budgets consistent with the performance objectives of section 3.1 and using a 45 cm receive antenna. These link budgets apply to the case of low power mode operation (120W TWTA per transponder). Note that the link margins will improve by 2.8 dB in high power mode.

Table 4 - Representative Link Budgets

EchoStar DBS Link Budget (Low Power Mode)				
Link Parameters		Clear Sky (New York)	Faded D/L (New York)	Faded D/L (Los Angeles)
Link Geometry:				
Tx E/S Range to Satellite (Cheyenne)	(km)	37,865	37,865	37,865
Rx E/S Range to Satellite	(km)	37,692	37,692	37,934
Uplink (per carrier):				
Carrier Frequency	(MHz)	17,500	17,500	17,500
Tx E/S Antenna Diameter	(m)	13.2	13.2	13.2
Tx E/S Power to Antenna	(dBW)	13.0	13.0	13.0
Tx E/S Antenna Gain	(dB)	65.0	65.0	65.0
Tx E/S EIRP per Carrier	(dBW)	78.0	78.0	78.0
Atmospheric and Other Losses	(dB)	0.4	0.4	0.4
Free Space Loss	(dB)	208.9	208.9	208.9
Satellite:				
Total PFD at Satellite	(dBW/m ²)	-85.0	-85.0	-85.0
Gain Attenuation	(dB)	0.0	0.0	0.0
G/T towards Tx E/S	(dB/K)	8.4	8.4	8.4
Saturated Transponder Output Power	(Watts)	120	120	120
Post-TWTA Output Losses	(dB)	1.8	1.8	1.8
Power to Antenna	(dBW)	19.0	19.0	19.0
Transmit Antenna Gain at beam peak	(dBi)	34.2	34.2	34.2
Sat'd EIRP at beam peak	(dBW)	53.2	53.2	53.2
EIRP towards Rx E/S	(dBW)	50.6	50.6	47.2
Downlink (per carrier):				
Carrier Frequency	(MHz)	12,500	12,500	12,500
Atmospheric and Other Losses	(dB)	0.2	1.9	1.0
Free Space Loss	(dB)	205.9	205.9	206.0
Rx E/S Antenna Diameter	(m)	0.45	0.45	0.45
Antenna Mis-pointing Error	(dB)	0.30	0.30	0.30
Rx E/S Antenna Gain	(dB)	34.0	34.0	34.0
Rx E/S G/T	(dB/K)	13.0	10.5	11.4
System (LNA+Sky) Noise Temp.	(K)	125	222	182
Total Link:				
Carrier Noise Bandwidth	(kHz)	24,000	24,000	24,000
(C/N) - Thermal Uplink	(dB)	31.9	31.9	31.9
(C/N) - Thermal Downlink	(dB)	12.0	7.8	6.1
(C/I) - Other Link Degradations	(dB)	20.0	20.0	20.0
(C/N) - Total Actual	(dB)	11.3	7.5	6.0
(C/N) - Total Required	(dB)	6.0	6.0	6.0
Excess Margin	(dB)	5.3	1.5	0.0
Availability	(%)	N/A	99.70	99.70

4 Responses to Numbered Paragraph 3 in the FCC Letter (ref. §25.114(c)(12))

4.1 Physical characteristics of the space station

Tables 5 and 6 below provide the predicted spacecraft mass budget and physical dimensions, respectively.

Table 5 - Mass Budget

Mass of spacecraft without fuel (kg)	2,000
Mass of fuel and disposables at launch (kg)	2,200
Mass of spacecraft and fuel at launch (kg)	4,200
Mass of fuel, in orbit, at beginning of life (kg)	1,000

Table 6 - Spacecraft Dimensions

Spacecraft Body Length (m)	~1.8
Spacecraft Body Width (m)	~1.8
Spacecraft Body Height (m)	~4.8
Deployed area of solar arrays (m ²)	~72

4.2 Electrical characteristics of the space station

Table 7 below provides the predicted spacecraft electrical budget.

Table 7 - Spacecraft Electrical Characteristics

Spacecraft Subsystem	Electrical Power at BOL (W)		Electrical Power at EOL (W)	
	At Equinox	At Solstice	At Equinox	At Solstice
Payload (W)	8,400	8,400	8,400	8,400
Bus (W)	1,800	1,000	1,800	1,000
Total (W)	10,200	9,400	10,200	9,400
Solar Array (W)	15,000	14,000	12,000	11,000
Depth of Battery Discharge (%)	75	N/A	75	N/A

4.3 Estimated operational lifetime and reliability of the space station

Table 8 below provides the predicted reliability of the communications payload and the spacecraft bus, in terms of the probability of survival.

Table 8 - Probability of Survival to EOL

Payload	0.87
Bus	0.80
Total	0.70

5 Responses to Numbered Paragraph 4 in the FCC Letter (ref. §25.114(c)(23))

5.1 Technical showing of satisfactory operation if all assignments in the BSS Plan were implemented (ref. §25.114(c)(23)(i))

At the outset, it is important to note the precise wording of §25.114(c)(23)(i) of the FCC's rules. In part, this rule states that the Applicant shall provide "... sufficient technical showing that the proposed system could operate satisfactorily if all assignments in the BSS and feeder link Plans were implemented." Tables 9 and 10 below provide all of these assignments, as modified, within 10° of the 86.5°W orbital location. For information purposes only, EchoStar also provides in Tables 11 and 12 those modifications within this range that have been proposed by the U.S. and other administrations.

Table 9 below lists all of the assignments in the ITU's Region 2 BSS Plan that are within 10° of the 86.5°W orbital location.¹

¹ These assignments include only the original ITU Appendix 30/30A Plan assignments and not any subsequent modifications, which are addressed later.

Table 9 - ITU Region 2 BSS Plan Assignments within $\pm 10^\circ$ of 86.5°W

Country	Nominal Orbital Location ($^\circ\text{W}$)	Separation from 86.5°W ($^\circ$)	Channels
Bermuda	96.2	9.7	Odd ch
Ecuador	94.8	8.3	Even ch
Argentina	93.8 to 94.2	7.5	All ch
Barbados	92.7	6.2	3,7,11,15,19,23,27,31
Jamaica	92.7	6.2	17,21,25,29
Bahamas	92.3	5.8	Even ch
Bermuda	92.3	5.8	Even ch
Belize	92.3	5.8	Even ch
Jamaica	92.3	5.8	Even ch
Canada	90.8 to 91.2	4.5	All ch
Cuba	89.2	2.7	3,7,11,15,19,23,27,31
Bahamas	87.2	0.7	1,5,9,13
Bolivia	87.2	0.7	3,7,11,15,19,23,27,31
Peru	85.8	0.7	Even ch
Guyana	84.7	1.8	11,15,19,23,27,31
Surinam	84.7	1.8	3,7,17,21,25,29
Trinidad & Tobago	84.7	1.8	1,5,9,13
Dominican Republic	83.3	3.2	4,8,12,16
Haiti	83.3	3.2	2,6,10,14
Canada	81.8 to 82.2	4.5	All ch
Brazil	80.8 to 81.2	5.5	All ch
Antigua and Barbuda	79.7	6.8	3,7,11,15
Montserrat	79.7	6.8	19,23,27,31
Saint Kitts and Nevis	79.7	6.8	17,21,25,29
British Virgin Islands	79.7	6.8	1,5,9,13
Dominica	79.3	7.2	18,22,26,30
Grenada	79.3	7.2	20,24,28,32
Saint Lucia	79.3	7.2	4,8,12,16
Saint Vincent and the Grenadines	79.3	7.2	2,6,10,14
Mexico	77.8 to 78.2	8.5	All ch

The Canadian assignments are the most significant ones in Table 9, from a coordination point of view, as these are spaced nominally 4.5° away from the proposed EchoStar-86.5W satellite, they occupy all 32 channels and they have geographically adjacent service areas. Successful coordination with these assignments over their service areas could be accomplished by tailoring the beam roll-off for the EchoStar-86.5W satellite.

The other assignment in Table 9 with an immediately adjacent service area is the Mexican one at 78°W, although the orbital separation from the proposed EchoStar-86.5W satellite is nominally 8.5° and so coordination should not be a problem.

The remaining assignments in Table 9 are for Central and South American and Caribbean countries that have distinctly separate coverage areas. Many of these use only a sub-set of the 32 available channels. The most critical ones of these are the Bahamas, Trinidad and Tobago, Cuba, Dominican Republic and Haiti because of the small orbital separation and the relatively close service areas. However, EchoStar is confident that, through detailed coordination with these Administrations, and careful design of the downlink beam roll-off of the EchoStar-86.5W satellite, the necessary agreements in the ITU can be obtained. The remaining foreign assignments in Table 9 have orbital separations in excess of 5° and this, combined with the natural beam roll-off towards these territories, will ensure adequate protection of those assignments.

Table 10 below lists all of the proposed modifications to the Region 2 BSS Plan that have been successfully coordinated and progressed to the Article 5 stage of the ITU Appendix 30 procedures.² This list is also limited to orbital locations within 10° of 86.5°W. Note that there are two Canadian filings at the 91°W and 82°W nominal orbital locations, both spaced nominally 4.5° away from the proposed EchoStar-86.5W satellite. Coordination between co-coverage DBS satellites with this orbital separation is addressed below.

**Table 10 - ITU Region 2 BSS Plan Modifications within ±10° of 86.5°W
(published under Article 5)**

Country	Nominal Orbital Location (°W)	Separation from 86.5°W	Network Name	Comments
CAN	91	4.5	CAN-BSS2	Includes US coverage
CAN	82	4.5	CAN-BSS1	Includes US coverage

² Latest available data from ITU dated 17 February 2004.

Table 11 below lists all of the proposed modifications to the Region 2 BSS Plan that have been published by the ITU pursuant to Article 4 of Appendix 30 of the Radio Regulations but which have not yet been successfully coordinated.³ This list is also limited to orbital locations within 10° of 86.5°W.

**Table 11 - ITU Region 2 BSS Plan Proposed Modifications within ±10° of 86.5°W
(published under Article 4)**

Country	Nominal Orbital Location (°W)	Separation from 86.5°W	Network Name	Comments
CAN	91.2	4.7	CAN (-91.2)	
CAN	91	4.5	CAN-BSS2	
CAN	90.8	4.3	CAN (-90.8)	
CAN	82.2	4.3	CAN (-82.2)	
CAN	82	4.5	CAN-BSS1	
CAN	81.8	4.7	CAN (-81.8)	
MEX	77.2	9.3	MEX-TDH1A	
MEX	76.8	9.7	MEX-TDH1B	

Table 11 essentially contains a set of Canadian filings within ±0.2° of 91°W and 82°W and Mexican filings within ±0.2° of 77°W. The Canadian and Mexican filings include an extension of the Canadian service area to include the United States. However, the minimum orbital separation from the Canadian filings is nominally 4.5°, which EchoStar is confident can be successfully coordinated, as explained in further detail below. The Mexican filings are more than 9° away from the proposed EchoStar-86.5W satellites, and so coordination with this should be very straightforward.

Table 12 below lists all of the proposed modifications to the Region 2 BSS Plan that have been submitted to the ITU but not yet published by the ITU under Article 4 of Appendix 30 of the Radio Regulations.⁴ This list is also limited to orbital locations within 10° of 86.5°W.

³ Latest available data from ITU dated 17 February 2004.

⁴ Latest available data from ITU dated 17 February 2004.

**Table 12 - ITU Region 2 BSS Plan Proposed Modifications within $\pm 10^\circ$ of 86.5°W
(submitted to ITU but not yet published under Article 4)**

Country	Nominal Orbital Location ($^\circ\text{W}$)	Separation from 86.5°W	Network Name	Comments
G	96.5	10	IOMBSS-1	
G	86.5	0	USAT-S3	
G	86.5	0	USAT-S3 MOD-A	
MEX	77.2	9.3	MEX-TVD2	
MEX	76.8	9.7	MEX-TVD1	

The UK filing at 96.5°W and the Mexican filings at nominally 77°W would be easily coordinated because of the wide orbital separation. The two UK filings at 86.5°W which are collocated with the proposed EchoStar- 86.5°W satellite cannot be coordinated by technical means. However, these proposed modifications to the BSS Plan may not be able to be successfully coordinated, or they may not be brought into use before they expire, in which case they would not be an impediment to later proposed modifications, such as for the EchoStar- 86.5°W satellite.

In light of the above, EchoStar believes that it can successfully coordinate with co-coverage co-frequency BSS networks that are nominally 4.5° away from the proposed 86.5°W satellite, and that a showing to this effect is sufficient to satisfy §25.114(c)(23)(i). This of course addresses coordination with all other US licensed DBS satellites, of which the closest are the EchoStar and DIRECTV networks in the 119°W orbit cluster. Appendix 1 to this Supplemental Technical Annex provides the necessary technical showing concerning the interference calculation between nominally 4.5° spaced DBS satellites operating with receiving earth stations as small as 45 cm in antenna diameter. Based on the results reported in Appendix 1 it can be inferred that coordination of the proposed EchoStar 86.5°W satellite with neighboring co-coverage co-frequency satellites can be accomplished without placing undue constraints on any of the satellite networks.

5.2 Analyses with respect to the limits in Annex 1 to Appendices 30 and 30A of the ITU Radio Regulations (ref. §25.114(c)(23)(ii))

A detailed analysis of the proposed EchoStar- 86.5°W satellite network with respect to the limits in Annex 1 of Appendices 30 and 30A of the Radio Regulations is given in Appendices 2 and 3 to this Supplemental Technical Annex. Appendix 2 addresses the limits in Appendix 30 (service downlink) of the Radio Regulations and Appendix 3 addresses the limits in Appendix 30A (feeder link).

6 Telecommand Frequencies to be Used During Transfer Orbit Operations

Rather than seeking a waiver for operation of the 14.0-14.5 GHz telecommand frequencies during transfer orbit, EchoStar will pursue a design that uses only the edges of the 17 GHz band for telecommand at all phases of the mission. The frequencies, polarization and coding of the telecommand transmissions shall be selected to minimize interference into other satellite networks and within the EchoStar-86.5W satellite network.

Appendix 1 to Supplemental Technical Annex (EchoStar-86.5W)

Demonstration of Compatible Operation Between DBS Satellites Spaced 4.5 Degrees Apart

1 General Approach to the Analysis

This Appendix provides a rigorous assessment of the interference calculations between two DBS satellites spaced 4.5° apart in the geostationary orbit. It illustrates the potential benefits of good-faith coordination between operators in which features of both systems can be exploited to the benefit of both parties. The results, which demonstrate that operation of co-coverage co-frequency DBS satellites spaced 4.5° apart is feasible, can be readily extended to relate to the proposed EchoStar-86.5W satellite coordinating with the neighboring US and foreign satellites with similar orbital spacing.

The interference assessment presented here is:

- (a) Limited to the downlink only because this is the critical link due to the relatively small size of the receiving earth station compared to the large feeder uplink earth station. With the large (typically 13 meter) feeder link earth station antennas in use today by the US DBS operators it is clear that uplink interference cannot be a significant issue with 4.5° orbital spacing;
- (b) Based on assessing the interference in terms of carrier-to-interference ratio (C/I) levels and, where necessary, further exploring of the impact on link availability. This approach provides more meaningful results than the assessment of OEPM (Overall Equivalent Protection Margin), which is the ITU procedural method for determining administrations affected by a proposed modification to the ITU's BSS Plan.

2 Factors to be Considered in the Assessment of Adjacent DBS Satellite Interference in a 4.5° Orbital Spacing Environment

In order to accurately assess in terms of C/I the potential interference from a neighboring satellite, the following factors must be taken into account:

- (a) **The relative EIRP difference between the interfering and wanted satellites**

This " $\Delta EIRP$ " directly affects the resulting C/I and will vary at different points in the wanted satellite service area. The magnitude is subject to some uncertainty as the EIRP levels of both the wanted and interfering satellites will likely vary over time due to TWTA degradation, as well as the possible different redundancy paths on the satellite output stages.

(b) The appropriate minimum off-axis angle towards the interfering satellite from the boresight of the receiving earth stations

There are several factors that must be taken into account in determining this angle:

- Although the satellites are nominally spaced 4.5 degrees apart this is a *geocentric* angle, and the off-axis angle must be the *topocentric* one (as seen from the receiving earth station). The actual topocentric angle will vary as a function of the location on the Earth, with smaller angles occurring at lower elevation angles.
- The station-keeping accuracy of the interfering and victim satellites must be considered. A worst-case assumption is that the interfering satellite could drift over to the extreme edge of its station-keeping box that corresponds to the minimum off-axis angle. In addition, the wanted satellite earth station may be aligned to the wanted satellite when it is also at the extreme of its station-keeping box where it is closest to the interfering satellite.
- The earth station pointing error will effectively reduce this off-axis angle. It is important to be able to predict this likely error as it becomes a major driver of the interference level for nominal orbital spacing in the range of 4.5°. This pointing error includes the following contributions:
 - The basic mechanical alignment error of the receiving antenna, due to the practicalities of the installation. For example, the installer may not have carefully peaked the signal strength meter, or may have disturbed the antenna pointing when tightening the antenna mount bolts. There could also be additional mechanical pointing errors introduced over time by effects such as wind loading, tree branches, ladders, etc.
 - The use of multi-feed receive antennas (such as the Dish 500 and Superdish antennas in the EchoStar system) also gives rise to additional pointing errors. The reason for this is that these antennas are manufactured with a fixed angular separation between the various feeds, corresponding to an *average* topocentric angular difference between the various wanted satellites. In some parts of the service area this will not be the accurate angle due to the fact that the topocentric angle varies depending on distance from the satellite (and hence elevation angle to the satellite). These antennas are usually aligned to one of the feeds only, which may not be the feed that is subject to the most interference from the interfering satellite. In this case an additional mechanical pointing error is introduced.

- (c) **The maximum gain discrimination of the receiving earth stations at the appropriate off-axis angles**

There are several standard ITU masks used to define the off-axis gain envelope (both co-polar and cross-polar) of receiving earth station antennas (e.g., "Region 2 Reference in AP30", "BO.1213", "DBLTVROI0001"). One of these reference antenna patterns will be used in the ITU assessment of interference performed using the MSPACE software. However, because of the wide range of different antenna types currently or planned to be used with the operational U.S. DBS systems, including the multi-feed dishes where the use of off-boresight feeds degrades the sidelobe performance, it is important to use actual antenna off-axis gain data rather than the ITU reference antenna patterns for this adjacent satellite interference analysis.

- (d) **The differences in the frequency plans of the interfering and wanted satellites, as far as the relative position of co-polarized guard bands is concerned**

The proposed EchoStar-86.5W satellite has been designed with a frequency plan different from the standard Region 2 BSS Plan, such that guard bands in the proposed new satellite fall in the co-polar transponders of the existing U.S. DBS satellites (or any other satellite with a frequency plan consistent with the original Appendix 30 Plan assignments). This results in a small reduction in the interference, compared to the case where the full EchoStar-86.5W satellite transponder power is assumed to interfere with the co-frequency, co-polar U.S. DBS satellite transponder. A simple ratio of the width of the guard band to the width of the transponder can be used to approximate the improvement factor.

- (e) **Modulation and coding used, which impacts the required C/N and hence the effect of the C/I**

The C/I that can be tolerated needs to be considered in relation to the required C/N level because the former degrades the latter, and therefore affects any link availability calculations. The modulation type (QPSK or 8PSK), and the level of coding used in the particular transponder, affects the required C/N and therefore needs to be considered.

3 Results from Representative Coordination Involving Adjacent Satellite Interference Analysis in a 4.5° Orbital Spacing Environment

This section provides a summary of the interference analysis that has been performed to date in the context of coordinating existing EchoStar satellites and a proposed satellite spaced 4.5° apart. The conclusions are indicative of the results that could be obtained in other situations of 4.5° spacing between DBS satellites across the CONUS orbital arc, and therefore are applicable to the case of the coordination of the proposed EchoStar 86.5°W satellite with neighboring satellites spaced nominally 4.5° apart (and greater).

The remainder of this section will provide numerical data for each of the factors considered in Section 2 above, as well as the overall C/I and availability results of the analysis.

3.1 The relative EIRP difference between the interfering and wanted satellites

In a completely homogenous situation, the optimum circumstance would be to have no difference between the EIRP levels of the adjacent satellites because this would minimize mutual interference. However, existing U.S. DBS satellites spaced 9° apart with different operational parameters are currently operating and serving tens of millions of subscribers. Significantly, the subscriber receive antennas were installed in the generous 9° spacing environment and therefore were not very susceptible to adjacent satellite interference resulting from possible mispointing of the antennas. As a result, it is important that the EIRP difference between the existing DBS satellites and the new 4.5° -spaced satellites be biased in favor of the existing satellites as explained further below.

In this example coordination, the optimum EIRP levels of the new satellite would be up to 2.4 dB lower than the actual EIRP level of the CONUS beam of the EchoStar satellites. This " $\Delta EIRP$ " value may vary at the reference cities considered and was by no means a constant, reducing to typically 0.5 dB for some cities. The impact of these values on the interference results is explained in Section 3.6, below.

EchoStar also uses spot beams on some channels (with multiple spatial frequency reuse) at some orbital locations in order to efficiently provide local-into-local broadcasts. These spot beams present different issues with respect to adjacent satellite interference in a 4.5° orbital spacing environment. Typically the spot beams exhibit a higher peak EIRP than the CONUS beams, but are required to operate down to relatively low EIRP levels at their edge in order to cover the DMAs (Designated Market Areas) they are able to serve. A beam by beam analysis of the EchoStar spot beams was made to determine the lowest EIRP level for each beam at which service might need to be provided. The results of this analysis give $\Delta EIRP$ levels as high as 8.9 dB at some spot beam peaks and as low as -3.4 dB at the edge of some spot beams.¹ The impact of these values on the interference results is explained in Sections 3.6 and 3.7, below.

3.2 The appropriate minimum off-axis angle towards the interfering satellite from the boresight of the receiving earth stations

The actual topocentric angle between the boresight of the earth station and the interfering satellite is calculated at all points of the wanted satellite service area using the following assumptions:

¹ A negative $\Delta EIRP$ level indicates that the EchoStar EIRP is lower than the proposed EIRP of the new satellite at that location.

- (a) The boresight of the receiving earth station would be aligned with the wanted satellite when the wanted satellite was at the extreme of its station-keeping box closest to the interfering satellite (*i.e.*, at 0.05° geocentric angle towards the interfering satellite from the nominal wanted satellite orbital location);
- (b) The interfering satellite would be at the extreme of its station-keeping box closest to the boresight of the wanted satellite (*i.e.*, at 0.05° geocentric angle towards the wanted satellite from the nominal interfering satellite orbital location);
- (c) Taking into account the actual latitude and longitude of the earth station and the wanted/interfering satellites in order to convert geocentric off-axis angles to topocentric off-axis angles.

An example of the above calculation for Washington, DC (38.9°N , 77.0°W), and the nominal interfering and wanted satellite locations, with station-keeping boxes of $\pm 0.05^\circ$ east-west, results in a worst-case topocentric off-axis angle of 4.85° .

The topocentric angle calculated above is the worst-case off-axis angle assuming no receive earth station pointing error. As explained in Section 2 above, there are several factors that can contribute towards this pointing error, as follows:

- The dominant mispointing effect is likely to be the mechanical misalignment error. This error is statistical in nature and difficult to quantify accurately. However, based on knowledge of the DBS installation procedures and the calibration of the signal strength meter in the receiver, only a relatively small number of subscriber earth stations will have pointing errors as high as 0.5° in the east-west direction.
- The additional pointing error for multi-feed receive antennas has been investigated in detail. The conclusion is that the additional pointing error introduced at some subscriber locations by the fixed feed spacing of a multi-feed receive antenna is more than offset by the improved off-axis gain performance of antennas of this type. These antennas use reflectors that are larger along the direction of the geostationary arc than the reflector of a single feed antenna. Therefore the worst-case interference assessment situation is that of the smallest (45 cm) single-feed antenna, as this has the worst off-axis gain performance in the direction along the direction of the geostationary arc.

Taking the above factors into account, the worst-case topocentric off-axis angles throughout the service area are reduced by the assumed aggregate statistical pointing error, for which a value of 0.5° has been used, as this is expected to cover the vast majority of the subscriber installations. In the Washington, DC example given above, the worst-case topocentric off-axis angle of 4.85° would be reduced by 0.5° to give a worst-case off-axis angle, including an allowance for pointing errors, of 4.35° . Over the service area of U.S. DBS satellites (including Alaska and Hawaii) the range of worst-case off-axis angles, including the 0.5° pointing error allowance, was found to be from 4.1° to 4.6° . Over CONUS the worst-case angle would be greater than 4.3° except for the extreme Northeast.

3.3 The maximum gain discrimination of the receiving earth stations at the appropriate off-axis angles

Off-axis gain discrimination data for the existing and planned EchoStar subscriber antennas was evaluated in detail over the range of worst-case off-axis angles determined in the previous sub-section (4.1° to 4.6° for CONUS, Alaska and Hawaii, or 4.3° to 4.6° for CONUS only). Note that service to Alaska and Hawaii typically requires somewhat larger antennas than 45 cm for the U.S. DBS systems, and so the off-axis gain data for the smallest (45 cm) antennas at off-axis gain angles less than 4.3° is not used in the interference calculation.

The most sensitive EchoStar receive antenna, in terms of having the lowest discrimination in the relevant off-axis angle ranges, is the single-feed 45 cm antenna. This antenna meets the ITU Recommendation BO.1213 in the angle ranges of interest, with some margin, and so the BO.1213 mask was used to determine the off-axis gain for the purpose of the interference analysis. Figure 1 below shows this mask for a 45 cm antenna and a peak gain of 34 dBi at 12.2 GHz.² The discrimination of this mask is 15.5 dB at 4.3° , 16.2 dB at 4.4° , 16.9 dB at 4.5° and 17.7 dB at 4.6° .

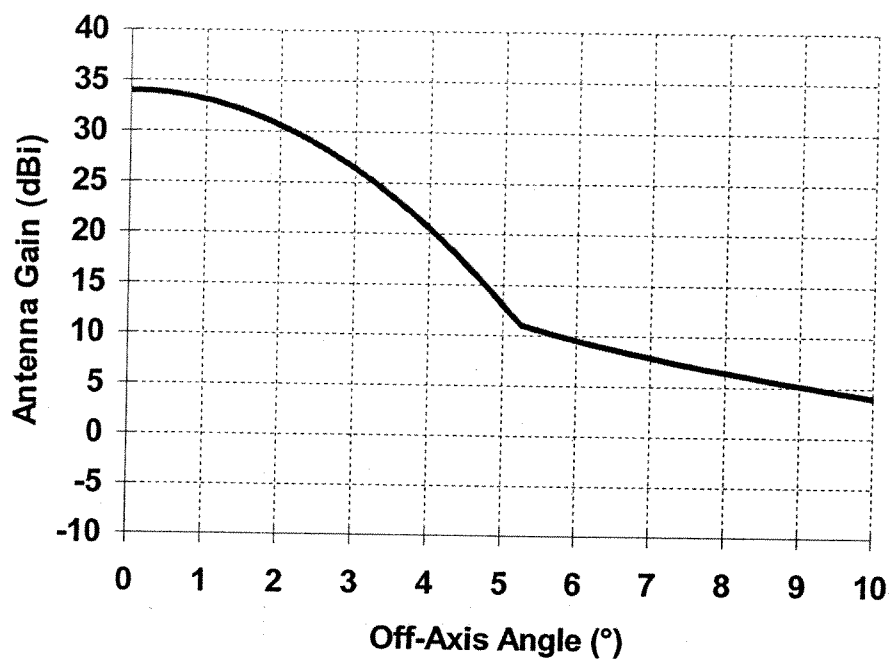
The multi-feed EchoStar receive antennas currently in use, as well as those in the development stage, all meet the BO.1213 mask assuming a diameter of greater than 50 cm. Figure 2 gives the BO.1213 mask for a diameter of 50 cm and a frequency of 12.2 GHz. The off-axis discrimination is markedly improved, compared with the values given above for the 45 cm antenna, with values of 19.1 dB at 4.3° , 20.0 dB at 4.4° , 20.9 dB at 4.5° and 21.9 dB at 4.6° .

It is also necessary to determine the off-axis cross-polar gain performance of the receive antennas so that cross-polar interference contributions can be correctly accounted for. Although the ITU off-axis gain masks also include cross-polar masks, these have been found to be far too conservative for the types of antennas currently used, and planned to be used, by EchoStar. Publicly available measurement data for DBS antennas shows that cross-polar discrimination levels in excess of 10 dB are readily achieved in the off-axis angular range of 3.5° to 5.5° .³ This is up to 7 dB better than the ITU cross-polar masks. For this reason the interference analysis assumes a cross-polar discrimination of 10 dB.

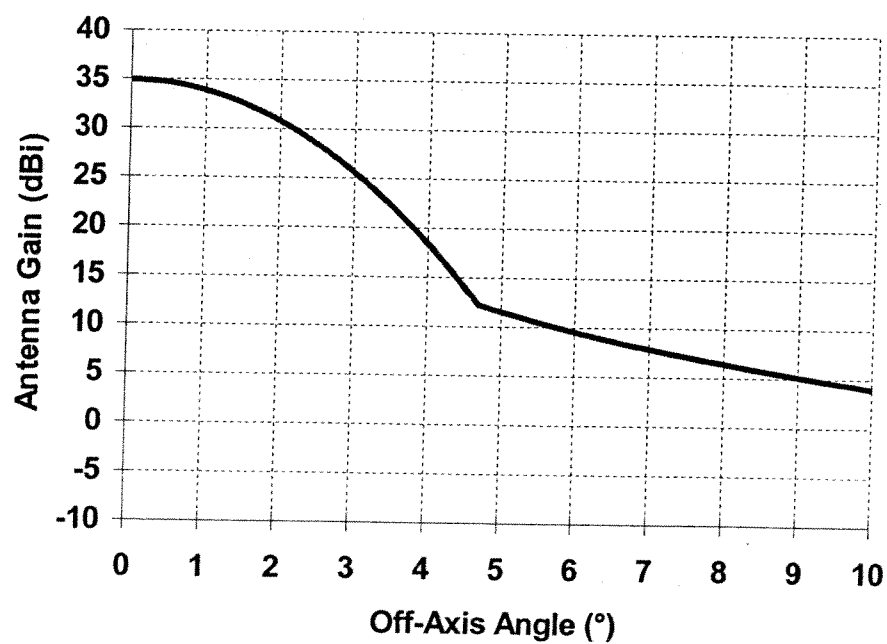
² 12.2 GHz is the lowest downlink frequency for U.S. DBS systems in ITU Region 2, and therefore should be the worst-case in terms of the beamwidth of the receive antennas.

³ FCC Report entitled "Analysis of Potential MVDDS Interference to DBS in the 12.2-12.7 GHz. Band"; Mitre Technical Report No. MTR 01W0000024, April 2001.

**Figure 1: BO.1213 gain mask for a 45 cm antenna
(12.2 GHz)**



**Figure 2: BO.1213 gain mask for a 50 cm antenna
(12.2 GHz)**



3.4 The differences in the frequency plans of the interfering and wanted satellites, as far as the relative position of co-polarized guard bands is concerned

To calculate the improvement from this effect it is assumed that the wanted signal occupied bandwidth is 24 MHz, and that this overlaps a 5.16 MHz guard band in the interfering satellite.⁴ The resulting reduction in interference is therefore in the ratio of 24 MHz to 18.84 MHz (i.e., 24-5.16), which is equal to 1.05 dB.

3.5 Modulation and coding used, which impacts the required C/N and hence the effect of the C/I

Demodulator threshold levels of 6.1 dB for QPSK and 8.0 dB for 8PSK have been assumed throughout this analysis as this is representative of the equipment and coding levels used in the EchoStar system. Note that this parameter value does not affect the C/I calculation, but it does affect the assessment of the link availability impact of the C/I.

3.6 C/I analysis and results

The C/I is calculated according to the following equations:

$$C/I = \Delta EIRP + G_w(\theta_w) - G_{wA}(\theta_I) + FDR \dots\dots\dots(1)$$

where:

$\Delta EIRP$	=	difference in EIRP between the wanted and interfering signals, in dB;
$G_w(\theta_w)$	=	gain of wanted earth station in direction of wanted satellite, in dBi;
$G_{wA}(\theta_I)$	=	effective aggregate of co-polar and cross-polar gain of wanted earth station in direction of interfering satellite, in dBi;
FDR	=	Frequency dependent rejection factor due to guard band of interfering satellite falling within the occupied bandwidth of the wanted satellite.

⁴ This is based on the fact that the spacing between center frequencies co-polar transponders is 29.16 MHz in the ITU Region 2 BSS Plan and this has been implemented in U.S. DBS systems.

$$G_{WA}(\theta_I) = 10 \log(10^{(G_{W,CP}(\theta_I))/10} + 10^{(G_{W,CP}(\theta_I) - XPD)/10}) \dots\dots\dots (2)$$

where:

$G_{W,CP}(\theta_I)$ = Co-polar gain of wanted earth station in direction of interfering space station, in dBi;

XPD = Cross-polar discrimination of wanted earth station in direction of interfering space station, in dB.

As an example of the application of the above, consider a location in the EchoStar service area where the $\Delta EIRP$ value is 2 dB, and the relevant offset angle, θ_I , is 4.5° , including the pointing error allowance. For a 45 cm antenna the value of $G_W(\theta_W)$ is 34.0 dBi, and the value of $G_{W,CP}(\theta_I)$ is 17.1 dBi. The aggregate off-axis gain, including allowing for co-polar and cross-polar effects with an XPD value of 10 dB, which is referred to as $G_{WA}(\theta_I)$ in the formulae above, has a value of 17.5 dBi, using Equation (2) above. The C/I can then be calculated using Equation (1) above to be $2 + 34.0 - 17.5 + 1.05 = 19.55$ dB.

This analysis was performed over the range of locations in the EchoStar CONUS+ beam service area, for the various EchoStar satellite types and for the different types of EchoStar receive antennas. This resulted in C/I levels in the range 19.3 to 22.3 dB, depending on location for the 45 cm antenna. Analysis for the multi-feed antennas resulted in higher C/I levels.

The corresponding C/I analyses for the EchoStar spot beams gave lower C/I at the edges of the spot beams because of the lower EchoStar edge EIRP levels as explained in Section 3.1 above. Nevertheless, even for the 45 cm receive antenna, the C/I range was still 14.5 to 20.7 dB at the spot beam edges, with much higher levels of 20.3 to 28.0 dB at the spot beam peaks.⁵

The lower C/I cases at the edge of some of the spot beams was analyzed in greater detail in terms of the impact on link availability due to this level of interference, and this is reported in Section 3.7 below.

⁵ Note that the majority of the service area of a spot beam will experience C/I levels closer to the beam peak values than to the beam edge values due to the steep contour roll-off at relative EIRP contour levels in the region of -6 to -9 dB.

3.7 Availability impact considerations

Section 3.6, above, reported on the C/I results obtained for the interference into existing EchoStar satellites from the proposed DBS satellite. For the EchoStar CONUS+ beams, the C/I levels were quite high, but for the EchoStar spot beams the worst-case results (i.e., for a low EIRP level at the edge of the spot beam) dropped to relatively low levels in some limited cases. Therefore, an availability analysis was performed to better understand the impact of these C/I levels in these particular cases. Here are the key conclusions from this analysis:

- (a) For all multi-feed receive antennas the C/I was equal to or greater than 18 dB in all cases at the edge of the spot beam.
- (b) Only the 45 cm single-feed receive antenna resulted in C/I levels at the edge of some of the spot beams falling below 18 dB. Of the sixteen EchoStar spot beams, ten achieved a link availability of 99.9% or greater, even with the lower C/I level. Three of the remaining six spot beams achieved an availability in excess of 99.7%. The remaining three spot beams were special cases where the apparent lower link availability at the beam edge could be tolerated for different system-specific reasons, as follows:
 - The beam that only achieved an availability in excess of 99.6% is intended to serve a notoriously difficult DMA which is spread over a very wide geographic area. The relatively small number of subscribers at the very edge of this DMA could be equipped with slightly larger antennas to compensate for the reduced link availability.
 - For the Hawaii spot beam the lower EchoStar EIRP means that subscribers would typically be equipped with receive antennas larger than 45 cm and so the theoretically calculated link availability is not relevant.
 - In the case of Puerto Rico, which is a high rain rate area, the availability achieved without the adjacent satellite interference is below 99% anyway, and the increase in unavailability due to the proposed satellite interference is only 7.4%. In other words, the relative impact of the interference is very small and the subscribers either are accustomed to somewhat lower availability anyway, or can use a larger receive antenna to obtain a higher link availability, in which case the effect of the interference would be further reduced.

The general conclusions from the investigation of link availability for low C/I situations are therefore that the majority of beams still maintain an excellent link availability (>99.9%) even in the presence of the interference from the 4.5° spaced adjacent satellite where the C/I is below 18 dB. More beam-specific investigation of the beams where the resulting availability is lower (assuming a 45 cm receive antenna) reveals special circumstances which make the theoretical calculation not relevant.

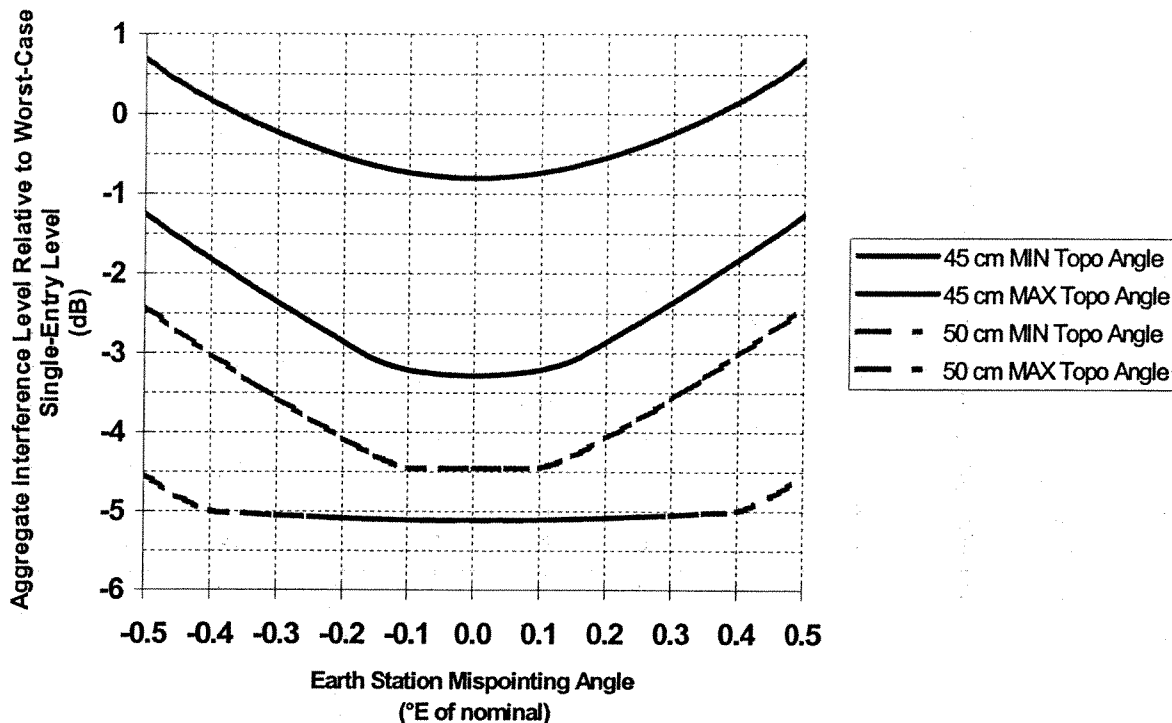
4 Consideration of Interference from Two Adjacent Satellites in a 4.5° Orbital Spacing Environment

All the interference analysis results presented so far are for the single-entry case of one adjacent satellite spaced nominally 4.5° away from the wanted satellite. If 4.5° spacing were to become the norm across the U.S. orbit arc, then the impact of two neighboring satellites, one spaced 4.5° away on either side of the wanted satellite must be considered. This situation is addressed in this section.

Sections 3.2 and 3.3, above, describe the use of the worst-case off-axis angle for the receiving earth station in the analysis performed. This essentially assumed that the receiving earth station was mispointed by 0.5° *towards* the interfering satellite. In this case the earth station would be pointed 0.5° *away from* a possible 4.5° spaced adjacent satellite on the other side of the wanted satellite, and the interference contribution from that other satellite would be correspondingly less. This aggregate effect has been analyzed as a function of the earth station pointing error and the results are summarized in Figure 3 below. The vertical axis is the aggregate interference level when the second adjacent satellite is taken into account, relative to the worst case single-entry interference into a 45 cm receive antenna that is mispointed by $\pm 0.5^\circ$. The worst-case for the purpose of this analysis is assumed to be at a location in the CONUS service area where the topocentric angle between the two adjacent satellites is at a minimum, such as the extreme Northeast of CONUS.⁶

⁶ The topocentric angle is calculated assuming the adjacent satellites are at the closest extremes of their station-keeping boxes. This angle varies from 9.6° in the Northeast of CONUS where the elevation angle is minimized to approximately 10.2° at the highest elevation angle in the service area.

**Figure 3: Increase in Interference Due to the 2nd Adjacent Satellite
(relative to 45 cm Single-Entry case with 0.5° Mispointing)**



The red lines in Figure 3 are for a 45 cm receive antenna and the blue lines are for a 50 cm antenna. The solid lines are for locations in CONUS where the topocentric angle is minimum and the dotted lines are where the topocentric angle is maximum.

Note that the solid red line indicates that the additional second adjacent satellite will increase the interference by 0.7 dB for the worst case pointing error of 0.5°. ⁷ However, as the pointing error is reduced, the aggregate quickly drops to a level below the worst-case single-entry level.

The dotted red line, which is the same 45 cm earth station as the solid red line, but located at a point in the service area where the topocentric angle between the neighboring satellite is maximized, shows considerably lower aggregate interference compared to the worst-case single-entry level for the minimum topocentric angle.

⁷ This is the only case where the aggregate interference is at a higher level than the worst-case single entry interference level. All the other lines in Figure 3 are below the 0 dB level (i.e., they are lower interference).

The corresponding blue lines, which are for a slightly larger receive earth station antenna of 50 cm, show significant improvement in the aggregate compared to the worst-case 45 cm interference level.

Note that the above analysis is also worst case in the sense that it inherently assumes that both neighboring satellites are transmitting the same EIRP value towards the particular point on the earth where the wanted system earth station is located, and this is unlikely to be the case in practice.

**Appendix 2 to Supplemental Technical Annex
(EchoStar-86.5W)**

**ITU ANNEX 1 OF APPENDIX 30
FOR USABSS-21 AT 86.5° W.L.**

Section 1 Limits for the interference into frequency assignments in conformity with the Regions 1 and 3 Plan or with the Regions 1 and 3 List or into new or modified assignments in the Regions 1 and 3 List.

This Section is not applicable as the USABSS-21 network will operate at an orbital location and with a service area that makes it a Region 2 modification.

Section 2 Limits to the change in the overall equivalent protection margin for frequency assignments in conformity with the Region 2 Plan.

With respect to § 4.2.3 c) of Article 4, an administration in Region 2 shall be considered as being affected if the overall equivalent protection margin¹⁶ corresponding to a test point of its entry in the Region 2 Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

- the Region 2 Plan as established by the 1983 Conference; or*
- a modification of the assignment in accordance with this Appendix; or*
- a new entry in the Region 2 Plan under Article 4; or*
- any agreement reached in accordance with this Appendix.*

The latest MSPACEg (v.4) ITU software has been used to check on affected administrations according to this section of Annex 1 of Appendix 30. The reference situation was used (file “SPS_ALL_IFIC2512.mdb”) for this analysis, which means that all the original Plan assignments, modifications published under Article 5 and modifications published under Article 4 are investigated for their OEPM degradation. The details of the EchoStar-86.5W (ITU name “USABSS-21”) satellite network was added to this database file, and identified as an “Addition” in order to test the effect it has on the other assignments in the Plan. The GXT files previously provided to the Commission were used for the beam coverage of USABSS-21.

¹⁶ *For the definition of the overall equivalent protection margin, see § 1.11 of Annex 5 of Appendix 30 of the Radio Regulations.*

The MSPACE results for non-US and for US networks are given as Attachment 1 to this Appendix. These results show the assignments where the threshold OEPM degradation criterion (0.25 dB) is exceeded. The tables provide the Administration, orbital position, satellite network, beam name, affected channels and the worst case OEPM degradation resulting from the addition of the EchoStar-86.5W satellite to the Plan.

The MSPACE results for non-US assignments show that certain of the assignments of the Bahamas (at 87.2°W), Canada (at 91°W ±0.2° and 82°W±0.2°), Mexico (at 77°W ±0.2°) and some other Caribbean and South American assignments are potentially affected, with a worst-case OEPM degradation for each of these as follows:

Bahamas:	18.37 dB
Canada:	0.60 dB
Mexico:	0.34 dB
Jamaica:	0.53 dB
Cuba:	1.1 dB
Dominican Republic:	0.81 dB
Peru:	0.34 dB

EchoStar recognizes that it will be necessary to hold detailed technical discussions with these administrations in order to obtain their agreement. However, EchoStar is confident that agreement with these potentially affected Administrations can be reached by various technical means. Appendix 1 demonstrates the viability of successful coordination between co-coverage co-frequency DBS satellites spaced nominally 4.5° apart, and is directly applicable to the coordination with the Canadian and Mexican administrations. Coordination with Jamaica, Cuba, the Dominican Republic and Peru would likely involve careful roll-off in the downlink beam design of the EchoStar-96.5W satellite. The very high OEPM degradation of the Bahamas assignment is due to the close proximity of the territory of the Bahamas to the US service area of the proposed EchoStar-86.5W satellite, and the small orbital separation of only 0.7°. However, there are only four out of 32 channels affected in this way.

The MSPACE results show that no existing US assignments in the Plan are affected.

Section 3 Limits to the change in the power flux-density to protect the broadcasting-satellite service in Regions 1 and 2 in the band 12.2-12.5 GHz and in Region 3 in the band 12.5-12.7 GHz.

With respect to § 4.2.3 a), 4.2.3 b) or 4.2.3 f) of Article 4, as appropriate, an administration in Region 1 or 3 shall be considered as being affected if the proposed modification to the Region 2 Plan would result in exceeding the power flux-densities given below, at any test point in the service area affected.

$$\begin{array}{ll}
 -147 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz})) & \text{for } 0^\circ \leq \theta < 0.44^\circ \\
 -138 + 25 \log \theta \text{ dB}(W/(m^2 \cdot 27 \text{ MHz})) & \text{for } 0.44^\circ \leq \theta < 19.1^\circ
 \end{array}$$

$$-106 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz})) \quad \text{for } \theta \geq 19.1^\circ$$

where θ is:

- the difference in degrees between the longitudes of the broadcasting-satellite space station in Region 2 and the broadcasting-satellite space station affected in Region 1 or 3.

The closest Regions 1 and 3 BSS orbital location in the Regions 1 and 3 Plan or List is at 37°W , which is 49.5° from the 86.5°W orbital location of USABSS-21. Therefore the $-106 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$ level from the above limits applies in this case.

The peak EIRP of USABSS-21 is 56 dBW. The minimum isolation to Region 1 or 3 territories is 30 dB. The resulting worst case PFD (in 27 MHz reference bandwidth) is therefore $-137 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$ (assuming 163 dB spreading loss for low elevation angles to Regions 1 and 3 territories). This PFD level is 31 dB below the threshold level of $-106 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$ given above. Therefore USABSS-21 is compliant with this Section.

Section 4 Limits to the power flux-density to protect the terrestrial services of other administrations.

With respect to § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 shall be considered as being affected if the consequence of the proposed modification to an existing assignment in the Region 2 Plan is to increase the power flux-density arriving on any part of the territory of that administration by more than 0.25 dB over that resulting from that frequency assignment in the Region 2 Plan at the time of entry into force of the Final Acts of the 1985 Conference. The same administration shall be considered as not being affected if the value of the power flux-density anywhere in its territory does not exceed the limits expressed below.

With respect to ... § 4.2.3 d) of Article 4, an administration in Region 1, 2 or 3 shall be considered as being affected if the ... proposed new frequency assignment in the Region 2 Plan, would result in exceeding a power flux-density, for any angle of arrival, at any point on its territory, of:

$$\begin{array}{ll} -148 \text{ dB}(W/(m^2 \cdot 4 \text{ kHz})) & \text{for } \theta \leq 5^\circ \\ -148 + 0.5 (\theta - 5) \text{ dB}(W/(m^2 \cdot 4 \text{ kHz})) & \text{for } 5^\circ < \theta \leq 25^\circ \\ -138 \text{ dB}(W/(m^2 \cdot 4 \text{ kHz})) & \text{for } 25^\circ < \theta \leq 90^\circ \end{array}$$

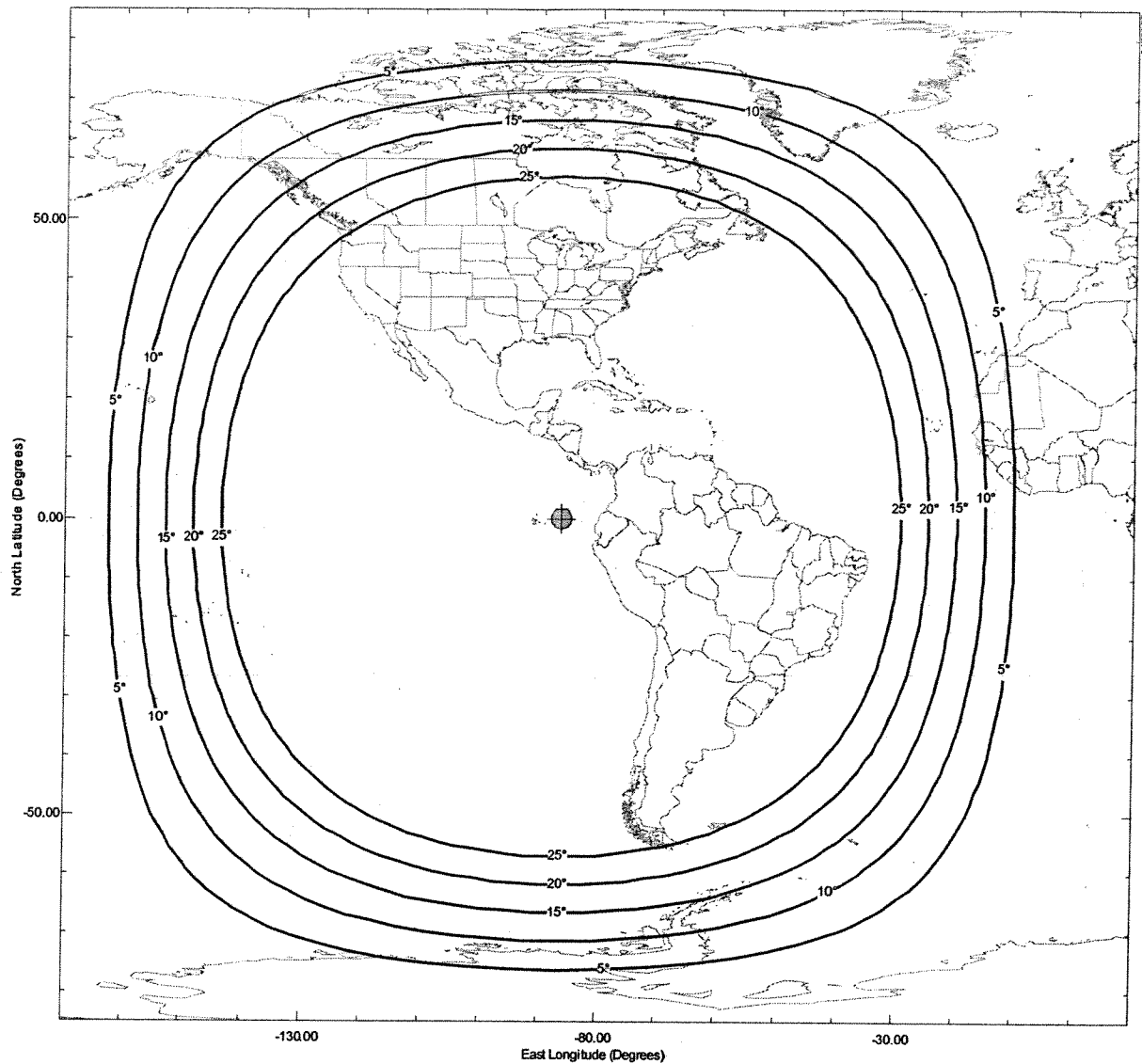
where θ represents the angle of arrival.

For territories of Regions 1 and 3 a PFD analysis similar to that for Section 3 was performed. The only change is that the reference bandwidth is 4 kHz instead of 27 MHz. The resulting highest PFD value over Region 1 or 3 territories is $-175.3 \text{ dB}(W/(m^2 \cdot 4$

kHz)) which is 27.3 dB below the most stringent PFD limit that could be applicable ($-148 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$, for elevation angles below 5°). Therefore the limits of this Section are met with margin.

For the territories of Region 2 countries a different approach is used. Firstly, dealing with the immediately adjacent countries of Canada and Mexico, 4.2.3 d) of Article 4 of Appendix S30 is pertinent. This provision states that the above PFD limits apply to countries not having frequency assignments in the broadcasting-satellite service in the channel concerned. Since both Canada and Mexico are assigned all 32 channels in the Plan, and therefore will not be deploying co-frequency terrestrial services, these limits do not need to be met on their territory.

For other Region 2 countries a detailed analysis was performed, and the results are summarized below. The figure below illustrates the elevation angle contours from the 86.5°W orbital location. As shown most Region 2 countries that are close to the U.S. are at an elevation angle of greater than 25 degrees.



The first situation analyzed is for countries that are at elevation angles of greater than 25°, in which case the minimum isolation from the USABSS-21 beam is only 2 dB. The resulting worst-case PFD for this situation is $-147.3 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$, which is 9.3 dB below the threshold value of $-138 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$ applicable to this elevation angle.

The second situation analyzed is for countries that are at elevation angles of less than 5°, in which case the minimum isolation from the USABSS-21 beam is more than 30 dB. The resulting worst-case PFD for this situation is $-175.3 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$, which is 27.3 dB below the threshold value of $-148 \text{ dB(W/(m}^2 \cdot 4 \text{ kHz))}$ applicable to this elevation angle.

The two extreme situations analyzed show significant margin with respect to the threshold values and all cases in between these two extremes show margins in this range. Therefore USABSS-21 is compliant with this Section.

Section 5 (Not used)

Section 6 Limits to the change in the power flux-density of assignments in the Regions 1 and 3 Plan or List to protect the fixed-satellite service (space-to-Earth) in the band 11.7-12.2 GHz in Region 2 or in the band 12.2-12.5 GHz in Region 3, and of assignments in the Region 2 Plan to protect the fixed-satellite service (space-to-Earth) in the band 12.5-12.7 GHz in Region 1 and in the band 12.2-12.7 GHz in Region 3.

The new limits adopted at WRC-03, applicable to Region 2 BSS, are reproduced below.

... an administration is considered as not being affected if ... a proposed modification to the Region 2 Plan, gives a power flux-density anywhere over any portion of the service area of its overlapping frequency assignments in the fixed-satellite service in Region 1, 2 or 3 of less than:

$$\begin{aligned}
 & -186.5 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) && \text{for } 0^\circ \leq \theta < 0.054^\circ \\
 & -164.0 + 17.74 \log \theta \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) && \text{for } 0.054^\circ \leq \theta < 2.0^\circ \\
 & -165.0 + 1.66 \theta^2 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) && \text{for } 2.0^\circ \leq \theta < 3.59^\circ \\
 & -157.5 + 25 \log \theta \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) && \text{for } 3.59^\circ \leq \theta < 10.57^\circ \\
 & -131.9 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz})) && \text{for } 10.57^\circ \leq \theta
 \end{aligned}$$

where θ is the minimum geocentric orbital separation in degrees between the wanted and interfering space stations, taking into account the respective East-West station-keeping accuracies.

All Regions 1 and 3 FSS satellites are greater than 10.57° from the 86.5°W location. Therefore the $-131.9 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz}))$ threshold level applies. As shown in Section 3 above the PFD per 27 MHz from USABSS-21 in the territories of Regions 1 and 3 is $-137 \text{ dB}(W/(m^2 \cdot 27 \text{ MHz}))$, which is equivalent to $-165.3 \text{ dB}(W/(m^2 \cdot 40 \text{ kHz}))$ and is 33.4 dB below this level. Therefore USABSS-21 is compliant with this Section.

Section 7 Limits to the change in equivalent noise temperature to protect the fixed-satellite service (Earth-to-space) in Region 1 from modifications to the Region 2 Plan in the band 12.5-12.7 GHz.

With respect to § 4.2.3 e) of Article 4, an administration of Region 1 shall be considered as being affected if the proposed modification to the Region 2 Plan would result in:

- the value of $\Delta T / T$ resulting from the proposed modification is greater than the value of $\Delta T / T$ resulting from the assignment in the Region 2 Plan as of the date of entry into force of the Final Acts of the 1985 Conference; and*
- the value of $\Delta T / T$ resulting from the proposed modification exceeds 4%,
using the method of Appendix S8 (Case II).*

From a review of the available ITU space network databases there are no assignments registered in the Earth-to-space direction in the frequency band 12.5-12.7 GHz. Therefore no Region 1 space station can be affected and USABSS-21 is compliant with this Section.

**ATTACHMENT 1 to
Appendix 2 to Supplemental Technical Annex
(EchoStar-86.5W)**

SUMMARY OF MSPACE RESULTS

MSPACEg software version: 4.00; OEPM degradation limit = 0.25 dB

FOR NON-US AND US ASSIGNMENTS:¹

Adm.	Orbital Position (°E)	Sat.Network Id.	Beam Name	Affected Channels	Max. OEPM Degradation (dB)
BAH	-87.20	BAHIFRB1	BAHIFRB1	1,5,9,13	18.368
CAN	-91.20	CAN01404	CAN01404	3,5,7,9,11,13,15	0.292
CAN	-82.20	CAN01405	CAN01405	1,3,5,7,9,11,13,15	0.435
CAN	-81.80	CAN01405	CAN01405	16	0.277
CAN	-91.20	CAN01504	CAN01504	15	0.261
CAN	-82.20	CAN01505	CAN01505	3,5,7,9,11,13,15	0.386
CAN	-82.20	CAN01605	CAN01605	3,5,7,9,11,13,15	0.282
CAN	-91.20	CAN03304	CAN03304	17	0.259
CAN	-91.20	CAN03404	CAN03404	17,19,21,23,25,27,29,31	0.318
CAN	-82.20	CAN03405	CAN03405	17,19,21,23,25,27,29,31	0.491
CAN	-81.80	CAN03405	CAN03405	32	0.285
CAN	-91.20	CAN03504	CAN03504	17	0.283
CAN	-82.20	CAN03505	CAN03505	17,19,21,23,25,27,29,31	0.434
CAN	-81.80	CAN03505	CAN03505	32	0.258
CAN	-82.20	CAN03605	CAN03605	17,19,23,27,31	0.312
JMC	-92.30	CRBBLZ01	CRBBLZ01	2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32	0.531
CUB	-89.20	CUB00001	CUB00001	3,7,11,15,19,23,27,31	1.098
DOM	-83.30	DOMIFRB2	DOMIFRB2	4,8,12,16	0.815
PRU	-85.80	PRU00004	PRU00004	2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32	0.339
CAN	-82.00	CAN-BSS1	CANBSS1A	1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31	0.567
CAN	-82.00	CAN-BSS1	CANBSS1B	2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32	0.309

¹ There are no US assignments affected by the proposed EchoStar-86.5W satellite, according to the MSPACE analysis.

Adm.	Orbital Position (°E)	Sat.Network Id.	Beam Name	Affected Channels	Max. OEPM Degradation (dB)
CAN	-91.10	CAN-BSS2	CANBSS2A	1,3,5,7,9,11,13,15,17,19,21,23,25,27,29,31	0.596
CAN	-91.10	CAN-BSS2	CANBSS2B	2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32	0.297
MEX	-77.20	MEX-TDH1A	MEXTDH1A	3,7,11,15,17,21,25,29	0.256
MEX	-76.80	MEX-TDH1B	MEXTDH1B	2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,32	0.343

**Appendix 3 to Supplemental Technical Annex
(EchoStar-86.5W)**

**ITU ANNEX 1 OF APPENDIX 30A
FOR USABSS-21 AT 86.5° W.L.**

Section 1 Not Used.

Section 2 Not Used.

Section 3 Limits to the change in the overall equivalent protection margin with respect to frequency assignments in conformity with the Region 2 feeder-link Plan.

With respect to the modification to the Region 2 feeder-link Plan and when it is necessary under this Appendix to seek the agreement of any other administration of Region 2, except in cases covered by Resolution 42 (Rev.Orb-88), an administration shall be considered affected if the overall equivalent protection margin corresponding to a test point of its entry in that Plan, including the cumulative effect of any previous modification to that Plan or any previous agreement, falls more than 0.25 dB below 0 dB, or, if already negative, more than 0.25 dB below the value resulting from:

- the feeder-link Plan as established by the 1983 Conference; or*
- a modification of the assignment in accordance with this Appendix; or*
- a new entry in the feeder-link Plan under Article 4; or*
- any agreement reached in accordance with this Appendix except for Resolution 42 (Rev.Orb-88).*

The MSPACE analysis provided in Attachment 1 to Appendix 2 includes the aggregate effect of both the uplink and downlink for the USABSS-21 satellite network.

Section 4 Limits to the interference into frequency assignments in conformity with the Regions 1 and 3 feeder-link Plan or with the Regions 1 and 3 feeder-link Lists or proposed new or modified assignments in the Regions 1 and 3 feeder-link Lists.

This Section is not applicable to Region 2 modifications.

Section 5 Limits applicable to protect a frequency assignment in the bands 17.3-18.1 GHz (Regions 1 and 3) and 17.3-17.8 GHz (Region 2) to a receiving space station in the fixed-satellite service (Earth-to-space).

An administration in Region 1 or 3 shall be considered affected by a proposed modification in Region 2 or an administration in Region 2 shall be considered affected by a proposed new or modified assignment in the Regions 1 and 3 feeder-link Lists when the power flux-density arriving at the receiving space station of a broadcasting-satellite feeder-link would cause an increase in the noise temperature of the feeder-link space station which exceeds the threshold value of $\Delta T / T$ corresponding to 3%, where $\Delta T / T$ is calculated in accordance with the method given in Appendix S8, except that the maximum power densities per hertz averaged over the worst 1 MHz are replaced by power densities per hertz averaged over the total RF bandwidth of the feeder-link carriers (24 MHz for Region 2 and 27 MHz for Regions 1 and 3).

Interim systems of Region 2 in accordance with Resolution 42 (Rev.Orb-88) shall not be taken into consideration when applying this provision to proposed modifications to the Regions 1 and 3 feeder-link Plan. However, this provision shall be applied to Region 2 interim systems with respect to the Regions 1 and 3 feeder-link Plan.

The table below shows the results of $\Delta T / T$ calculations for the closest spaced Region 1 and 3 orbital locations. Data is provided for all Region 1 and 3 orbital locations that are visible from either of the two feeder link earth station sites of the USABSS-21 network. The calculation of $\Delta T / T$ assumes the peak receive gain of the Region 1 and 3 space stations, and a 900K receive system noise temperature. Note that the results are all well below the 3% $\Delta T / T$ criterion. Therefore USABSS-21 is compliant with this Section.

Closest Region 1 or 3 Feeder Link Space Station			Orbital Separation from USABSS-21 at 86.5°W	Calculated $\Delta T / T$ (%)
Beam Name	Orbital Position (°E)	Peak Receive Antenna Gain (dBi)		
F – OCE10100	-160	32.58	73.5	0.004%
FJI – FJI19300	-178	44.16	91.5	0.050%
SMO – SMO05700	-178	48.88	91.5	0.147%
KIR – KIR 100	176	42.6	97.5	0.034%
TUV – TUV00000	176	46.93	97.5	0.091%
TON – TON21500	170.25	44.64	103.25	0.053%
IRL – IRL21100	-37.2	48.08	49.3	0.118%
NGR – NGR11500	-37.2	38.47	49.3	0.013%
AND – AND34100	-37	48.88	49.5	0.141%
GMB – GMB30200	-37	47.69	49.5	0.107%
GUI – GUI19200	-37	42.29	49.5	0.031%
POR – POR 100	-37	47.17	49.5	0.095%
MTN – MTN 100	-36.8	37.55	49.7	0.010%
SMR – SMR31100	-36.8	48.88	49.7	0.141%
CPV – CPV30100	-33.5	47.56	53	0.103%
DNK – DNK090XR	-33.5	43.48	53	0.040%
DNK – DNK091XR	-33.5	44.73	53	0.054%
G – G02700	-33.5	43.23	53	0.038%
ISL – ISL04900	-33.5	46.67	53	0.084%
ISL – ISL05000	-33.5	44.67	53	0.053%
LBR – LBR24400	-33.5	45.13	53	0.059%
SRL – SRL25900	-33.5	47.2	53	0.095%

Section 6 Limits applicable to protect a frequency assignment in the band 17.8-18.1 GHz (Region 2) to a receiving feeder-link space station in the fixed-satellite service (Earth-to-space).

This Section is not Applicable to Region 2 modifications.